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EDITORIAL NOTES

BENZOLE RECOVERY

THE recent Paper by Mr. Kenneth Sheard, of Messrs. Newton Chambers & Co., Ltd., on wartime aspects of benzole recovery will have been studied with both interest and profit. It was given to the Western District of the Scottish Junior Gas Association on Jan. 18, and we published it in the "JOURNAL" of Jan. 22. It was a helpful contribution in many ways, from the general aspect of benzole recovery to the particular aspect of working recovery plant to the best advantage. Prior to the war benzole recovery was a controversial subject, and it was discussed very thoroughly in these columns and not a little heatedly at many meetings of both senior and junior gas associations. We considered the matter from all angles, and expressed surprise that, since the Government had granted a subsidy of 8d. a gallon on this home-produced motor spirit, more undertakings were not extracting it from gas and that more undertakings actually recovering benzole were not extracting greater amounts.

We fully realized, as we appreciate to-day, that, from the purely economic aspect, recovery is affected by local conditions, particularly with regard to the prices of coal and coke, and the market which can be found for the additional coke produced as an inevitable result of benzole extraction. What we urged insistently, however, was development of the coke market, as we feel certain it can be developed and at a reasonable profit —at all events under normal peacetime conditions. We stressed the need for co-operative marketing and technical research on the utilization of coke, and we stressed, too, the need for its careful preparation, holding the opinion that expenditure in this direction was well repaid. As a matter of fact, during the ten years preceding the outbreak of war, a very great deal of good work was accomplished. Following the pioneering activities of the London & Counties Coke Association, which proved so eminently successful, other co-operative organizations operating on similar lines were set up in various parts of the country, and the outlook was very promising. A good coke market means so much to the Gas Industry—to the price at which gas can be sold—and the bearing of the coke market on benzole recovery was fully brought out in an analysis which we made and which we published in the "JOURNAL" of Dec. 14, 1938. We showed what the Industry was missing in terms of £ s. d. if it could not dispose of the extra coke consequent on benzole recovery.

On the outbreak of war the question of benzole recovery took on a new complexion. A national service in times of peace, it becomes of far greater and wide-reaching importance in time of war, when the production of the maximum amount of home-produced motor spirit and the maximum amount of toluene for the manufacture of high explosives is essential. The Government asked for this maximum, or at any rate as much as was possible practicably ; and it was disheartening in the early stages of the war to find that gas engineers were still discussing the pros and cons of benzole and toluole recovery—products vital to the prosecution of the struggle. It was out of joint that problematical increases in the cost of the gaseous therm—increases in the circumstances of an insignificant order—should be debated.

We would mention here that, just before the outbreak of war the Institution published a confidential Communication dealing with the improvization of recovery plant, and the adapting of existing gas scrubbing units for benzole extraction. This Communication set out in detail what could be done by gas undertakings themselves to construct recovery plant from existing materials normally found in works stores, standard pipes and fittings, and items such as disused cast-iron gas mains, which would formerly have been classed as scrap material. Full information was given in the publication regarding the dimensions and arrangements of the various components, the oil circulation required, steam and water consumption entailed, and the efficiency of recovery which could be expected from such plants.

Fortunately the essential nature of the task was, after some time, brought home, and the Industry generally set to with a will to fulfil an urgent national need. Production of benzole and toluole by the Industry has increased steadily. An important step was taken in June, 1940, in the appointment, under the auspices of the Mines Department, of the Advisory Committee on Benzole Recovery, on which Committee are members of the Gas and Coking Industries. Contractors were represented through the Society of British Gas Industries, and in his Paper Mr. Sheard referred to some of the work carried out by this Committee. Whole-time technical officers were appointed to act in an advisory capacity so as to afford every assistance to gas-works and coke ovens in regard not only to the installation of new plant, but also to improving the efficiency of existing plant. The Committee also had the voluntary assistance of the engineers of many gas and coke oven undertakings who were willing to give their colleagues the benefit of their experience. Among other matters, the case of the smaller undertakings carbonizing up to 15,000 tons of coal per annum was considered. The course adopted by the contractors was an admirable one. It was to develop a plant of standardized design for each of three sizes of works, of half, one, and one and a half million cu.ft. of gas per day. An approved list of contractors was made and undertakings were advised accordingly in connexion with work of this nature.

Mr. Sheard devoted part of his Paper to a description of the recovery plant designed particularly for these smaller undertakings by the firm with which he is connected—a plant simple in design and simple in operation. It may be mentioned that the entire oil circulation through the plant is controlled by one valve. The extraction efficiency is of the order of 85% of the benzole in the gas. He also dealt with what can be done to increase the efficiency of benzole extraction in existing installations, pointing out that when higher extractions of benzole are aimed at, the supervision and technical control of the plant should receive more attention than perhaps has been customary. Most plants built in recent years have been fitted with automatic controls, and at some works, provided the benzole make averaged about two gallons per ton and the calorific value of the gas remained satisfactory, no one worried very much about the working of the plant itself. While, he observed, this speaks well for the design, in many cases greater attention would have been well repaid. A typical example of such an instance is to be found in the formation of growths on condenser coils, dephlegmator tubes, and cooler pipes. Again, evaporation

from storage tanks during summer months, though comparatively small, can cause an appreciable loss of benzole over a period. Such tanks are often vented to atmosphere, but where practicable it is an advantage to couple up these vents to a small scrubber down which the cold debenzolized oil flows on its way from the coolers to the main gas scrubber. The Author concluded his Paper by consideration of general policy regarding benzole recovery, naturally referring to the incidence of the coke market on the economics of the process. In this connexion the Government's policy for increasing home-produced agricultural products has opened up new fields in the direction of drying grass and grain, for which purpose coke is finding extensive use. The importance of this development will undoubtedly increase. Then military establishments constitute a large potential market, while the Government urges the stocking of coke against possible emergencies. He asserted, and we think with every justification, that there are very few cases where the installation of a benzole plant does not show a good return for the capital invested, and the installation ends by being merely a wartime emergency plant. The undertaking which installs a recovery plant is in the ordinary way providing a money-making accessory, and at the present time is assisting greatly in the war effort.

ACTION IN EMERGENCY

IN the " JOURNAL " of Sept. 18, 1940, we referred to a booklet issued by the London Region Gas Centre, the purpose of which was to give wardens and other A.R.P. personnel guidance as to the steps they should take when confronted with damage to gas supplies in streets or in premises. The booklet was subsequently reprinted by The Institution of Gas Engineers with certain amendments and additions to conform with slight variations in local practice. The original booklet included a recommendation, which we considered significant, relating to gas pipes in buildings. It was this : " If these [*i.e.*, such pipes] are damaged, the first recourse should be to turn off the main cock at the meter if this is accessible." This, as we commented at the time, presupposed that the occupier of the premises had not turned off the gas on hearing the warning of the siren ; and we expressed the view that, all things considered, the turning-off of the gas by the occupier in these oft-occurring circumstances does not make for maximum safety. We pointed out that in most areas of gas supply a large majority of the dwellings have in them modern thermostatically-controlled gas appliances incorporating a pilot supply. To turn off the gas at the meter is not sufficient. We took a hypothetical case of an elderly lady. Has she, we asked, on the sound of the " Alert " to turn off the gas at the meter, turn off the gas pilot at, say, the refrigerator, then the sink heater, then the cooker oven tap, and then the central heating unit? If she turns off the gas at the meter only, will she remember to relight at once all the pilots to the appliances ? Among other observations, we remarked : Let us assume . . . that the warning siren sounds just when the gas supply to the oven has been ignited, the thermostat set to the appropriate number, and, say, a casserole inserted in the oven. If the gas is shut off at the meter, then obviously the preparation of the meal will have to be abandoned till the "All Clear " is sounded.

What makes us revert to this subject was a letter published in *The Times* on Thursday last. It concerned a gas consumer who had practically the whole of his property destroyed by enemy action, one of the few things left intact being the gas meter under the stairs. It would appear from the letter that subsequently he received a gas account which included a charge for " a leakage which took place as a result of a fracture in the installation." He asked for further information regarding this charge, and was told that had the main tap been turned off upon the sound of the air-raid warning the escape could not have occurred. This does raise an important point. At the beginning of the war the Government urged the public to take the precaution of turning-off the gas at the meter on hearing the warning siren. Those were the days when, at the warbling of the siren, everybody took cover—or, at least, everybody was advised to do so. Work was stopped ; there was no " business as usual." Experience of the results of this action brought about different ideas. The general instruction nowadays is to continue work where possible during an alert, and this implies, among other things, that the gas should not be turned off at the meter. We think that the appropriate National Body speaking for the Gas Industry could usefully give a general recommendation in this respect.

CONTINUOUS HEAT SERVICE

IN these columns some little time ago we spoke of the problems arising from actual interruption of gas supply as a result of enemy bombing—*i.e.*, temporary inability of undertakings to supply gas as distinct from temporary inability to give a supply which in normal times would have been deemed as of adequate pressure. With a gas supply of low pressure much can be done by adjustment of appliances or, in extreme cases—we are thinking particularly of factories engaged in war work—by the installation of fans or boosters. In the light of experience, however, we asked whether gas undertakings should recommend firms and factories to install alternative heating agents to cope with temporary interruptions. The idea of suggesting as a standby to town gas coal, oil, producer gas, or even petrol-air gas cannot be a pleasant one to an Industry which has built up its goodwill very largely through continuity of good service, with the factual statement in peacetime that " Gas never lets London (or the country for that matter) down."

Changed times—and have times changed ?—demand revision of thought and practice, but we hold the opinion that the Gas Industry has everything to gain and nothing to lose in goodwill and national service in helping to its utmost, and with its special knowledge of fuel utilization, both gaseous and solid fuel, to ensure that the consumer receives a continuous heat service. This applies to the industrial consumer and it applies also to the domestic consumer. Lack of heat is a very serious matter. We welcome, therefore, alternative appliances and methods which the Industry can, in the interests of gas consumers, confidently recommend and, indeed, could offer. We are thinking for the moment of the domestic consumer. Suppose, for example, in the case of temporary failure of gas supply the undertaking concerned could supply for cash or on loan at a reasonable figure a solid fuel fired and inexpensive cooking appliance. It seems to us (and on occasion, in common with most of our friends and acquaintances, we have been unhealthily close to bursting bombs) that a service such as this would be received with gratitude, and would help rather than hinder future gas usage. For which reason we are pleased to note a movement among certain manufacturers of appliances closely associated with the Gas Industry to produce what may be termed " low-priced standbys." One such appliance which we have seen is applicable to other than purely domestic purposes. In battery formation the appliances are applicable to emergency communal feeding and the like, and their flexibility in this direction will be apparent.

The Gas Salesman's Pocket Book

Although we have not advertised it in any way, we have had so many enquiries for a 1941 edition of the *Gas Salesman's Pocket Book* that some explanation of its non-appearance is called for. When war began, just as the 1940 edition was in preparation, we were in some doubt as to the advisability of proceeding with it, but decided that, with thorough revision to bring the information section into line with the times, it would serve a very useful purpose. Our faith was well justified by the demand, but so much new matter was introduced at that time that we could not visualize the collection of enough really useful new information this year to justify our asking gas undertakings to buy copies in present circumstances. We have, of course, always understood that it is the information section rather than the diary which has made such a very wide appeal in the Industry, and it has been our endeavour year by year to keep it up to date by revision and addition.

We are binding up a few sets of sheets of last year's information section to preserve the continuity of a work of reference which has won such popularity in the Gas Industry. We are not offering this limited 1941 Edition for general sale, but if anybody requires a copy for any special purpose, we shall be pleased, within the moderate limits of our stock, to pass them on at 2s. a copy.

Personal

As announced in last week's "JOURNAL" Mr. R. K. LAW, who was Assistant Gas Manager at Marple, is leaving to take up a position with the Woodall-Duckham Companies. On Jan. 17 he was the recipient of a wristlet watch from his colleagues. The presentation was made by Mr. W. H. Gledhill, recently appointed Engineer and Manager at Marple, in succession to Mr. J. L. Law, father of Mr. R. K. Law.

* * *

On leaving St. Helens Gas Department to take up new duties as Distribution Engineer and Sales Manager with the County Council of Lanark, as announced in the "JOURNAL" of Jan. 22, Mr. H. FIRTH was presented with a dinner service by his colleagues. The presentation was made by Mr. R. L. Greaves, Engineer and General Manager. Mr. Firth began his career with the Halifax Gas Department, and for two years before going to St. Helens he was Distribution Engineer there.

* * *

Mr. DAVID L. DICKSON, Engineer and Manager of the Newport (Fife) Undertaking, has been appointed Engineer and Manager to the Airdrie Corporation Gas Department in succession to the late Mr. A. Kellock. Mr. Dickson takes up his new duties on Feb. 17.

* * *

The Council of the Institution of Automobile Engineers has recently announced the award of the Crompton Medal to Dr. J. S. CLARKE, Experimental Engineer to the Industrial Heating Section, Birmingham Gas Department, for his Paper on "The Use of Gas as a Fuel for Motor Vehicles," this being the best Paper read before the senior branches of the Institution for the Session 1939/40. The Crompton Medal is the premier award of the Institution.

* * *

Among further members of the Gas Industry to be recognized for bravery, the following names have appeared in recent lists of awards published in supplements to the *London Gazette*:

George Medals go to Mr. CHARLES TAYLOR, a valveman employed by the Sheffield & District Gas Company, for extinguishing fire in punctured gasholders and then plugging the holes made by the incendiary bombs; and to Mr. A. E. SMITH and Mr. J. T. BONNING, gasholder repair men, of the City of Birmingham Gas Department.

For gallantry in dealing with a burning holder Mr. FRANK WILSON, foreman-in-charge of the Salford Corporation Gas-Works, is the recipient of the Order of the British Empire.

Obituary

Kenneth Aird

We announce with regret the death of Mr. KENNETH AIRD, at "Jesmond," Liss, Hampshire, on Friday, Jan. 31, after a short illness. He had a very serious illness in 1936, from which he never completely recovered.

In 1897 Mr. Aird joined the Board of Glover & Main, Ltd., Gas Engineers, and their Subsidiary Companies—Thomas Glover & Co., Ltd., Gas Meter Manufacturers, and R. & A. Main, Ltd., Gas Stove Manufacturers. He remained in London until 1908, during which time a complete and modern stove and meter works was developed at Edmonton. He then moved to Scotland to take charge of the business of R. & A. Main, Ltd., in the North. In 1910 he was appointed a Managing Director of R. & A. Main, Ltd., and subsequently a Managing Director of Thomas Glover & Co., Ltd.

In 1924, at the desire of his co-Directors, Mr. Aird returned to London to act as Head Managing Director of the two firms. On the death of the Rt. Hon. T. McKinnon Wood in 1927, he was appointed Chairman of the three allied Companies.

For 43 years he occupied a conspicuous position in the Gas Industry, and devoted unceasing attention to the affairs of the Companies. In all matters of business and finance his advice was invaluable. In 1931 he was elected a Member of The Institution of Gas Engineers.

His loss will be keenly felt by his co-Directors, members of the Staff, and his many friends in the Gas Industry. He leaves a widow, a son, and a daughter. His son, Lieut. Peter D. M. Aird, was appointed a Director of the Companies in 1939, and is at present serving with H.M. Forces.

* * *

The death occurred at Ross-on-Wye on Jan. 30 of Dr. H. S. HELE-SHAW, D.Eng., D.Sc., LL.D., F.R.S., at the age of 86. A Past-President of the Institution of Mechanical Engineers, Dr. Hele-Shaw became First Professor of Engineering at University College, Bristol, in 1881, later holding the appointment of Emeritus Professor at Liverpool. He subsequently went to the Transvaal to organize technical education there.

An Interesting Series of Lectures was recently held in Birmingham when the Ministry of Food engaged well-known demonstrators to illustrate ways and means of making the best of things when public supply services have been dislocated by enemy action. The proceedings were opened by Mr. F. Grisewood, of B.B.C. fame, who urged the wider support of communal kitchens. On Jan. 22 the demonstrator was Miss Fitzgerald, of the Leamington Priors Gas Company, who showed how to use a biscuit tin as an oven and explained the principles of the hay box.

Letter to the Editor

Creosote for Motor Transport

SIR,—I was interested to read in your issue of Jan. 29 your leader on creosote for motor transport. I was sorry, however, to note that no reference was made to the work of my father, the late Lt.-Col. T. Wilton, Superintendent of the Tar-Works, Beckton, many years ago.

As a youngster, I, personally, remember him working on creosote oil for motor fuel throughout the early part of the last war, and towards the latter end he was experimenting with the use of solid naphthalene. I myself drove in the car many times and know something of the fuel consumption, speed, advantages, and disadvantages.

The references you make in your article are so long after this that I was rather surprised no reference to the early work was made.

Yours, &c.,

T. O. WILTON.

The Old House,
London Road,
Horsham, Sussex.
Jan. 31, 1941.

Institution of Gas Engineers

The following elections to membership of The Institution of Gas Engineers have been made:

To Membership (4)

Adams, Hubert Leslie, Manager, Fermoy Gas Company, Ltd., and Tipperary Gas Company, Ltd.
Foster, Douglas Alan, Assistant Engineer, Wellingborough Gas Light Company, Ltd.
Smith, Maurice Lee, Engineer and Manager, Colchester Gas Company.
Wilkin, Cecil Raymond, Manager, Rochdale Road Works, Manchester Corporation Gas Department.

To Associate Membership (29)

Allen, Frank, Engineer and Manager, Clacton Urban District Council Gas and Water Department.
Ashworth, Sydney, Assistant Engineer, Darwen Corporation Gas Department.
Banner, George Ernest, Senior Technical Assistant, Isle of Thanet Gas Light and Coke Company.
Basford, Thomas John, Service Supervisor, Gas Light and Coke Company.
Bradshaw, Joseph Tarver, B.Sc.Tech., Technical Carbonizing Engineer, West's Gas Improvement Company, Ltd.
Brock, Andrew, Gas-Works Chemist, Dalmarnock Gas-Works, Glasgow Corporation Gas Department.
Fleming, John Baxter, Technical Assistant, Glasgow Corporation Gas Department.
Fornachon, Geoffrey, Assistant Carbonizing Superintendent, Stockport Gas Department.
Gardner, David, Deputy Engineer and Manager, Burgh of Motherwell and Wishaw Gas Department.
Gower, Reginald Arthur, Industrial Representative, Tottenham and District Gas Company.
Groom, Roy Dove, Distribution Superintendent, Southport Gas Department.
Guyan, James, Technical Assistant, Aberdeen Corporation Gas Department.
Hampton, Thomas Howard, Assistant Distribution Superintendent, Douglas Gas Light Company, Isle of Man.
Huxham, Sidney Charles, Assistant Engineer, Ilfracombe Gas Company.
Knight, James Edmund, B.Sc., Technical Assistant, Exeter Gaslight and Coke Company.
Lynch, William Joseph Herbert, Assistant Mains Superintendent, Tottenham and District Gas Company.
Meade, Stanley George, Assistant Engineer and Chemist, Newport (Mon.) Gas Company.
Plumpton, Reginald Roy, District Representative, Tottenham and District Gas Company.
Rivkine, James, Industrial Representative, Gas Light and Coke Company.
Roberts, Thomas William, Assistant Engineer, Borough of Loughborough Gas Department.
Robinson, Robert Frederick, Assistant Engineer, Watford and St. Albans Gas Company.
Sage, Edgar Robertson, Deputy Assistant Distribution Superintendent, Perth Corporation Gas Department.
Santley, Ronald, Technical Assistant, Radcliffe, Farnworth, and District Gas Company.
Shortland, George, Chemist, Sunderland Gas Company.
Sorley, John, Works Manager, Burgh of Motherwell and Wishaw Gas Department.
Stokes, James Lawrence, Technical Representative, Lea Bridge District Gas Company.
Stokes, Stephen Henry, Assistant Engineer and Manager, Elland-cum-Greetland Gas Company.
Twist, George Henry Anderson, Distribution Superintendent, Lincoln Corporation Gas Department.
Witt, Walter Stafford, Technical Special Representative, Gas Light and Coke Company.

London and Counties Coke Association

IN its Report for the year ended June 30, 1940, the Central Committee of the Association states that the tonnage of coke produced for sale was 3,640,410, as compared with 3,841,605 in the previous year. The former figure is based on tonnages for the calendar year of 1939, insofar as most gas undertakings are concerned, and includes, therefore, three months of the war period, which would account for the reduction, the first in the Association's history.

Since the outbreak of war the National Federation of Gas Coke Associations, of which the L.C.C.A. is a member, has done much towards co-ordinating the coke price and supply position throughout the country and as between gas and hard coke. All the applications for general increases in coke prices since the war have been made through the Federation. It would have been difficult to conduct negotiations with the Mines Department except on a national basis because they showed disinclination to work with an Association like the L.C.C.A. which could speak for only a part of the country.

The other members of the Federation are the Midland Counties' Coke Association, the Lancashire and District Coke Association, and the Home Sales Coke Association (North-East Coast). Similar District Coke Associations are in course of formation in Scotland, Wales, and Yorkshire and, in the meantime, those districts have representatives on the General Committee, which is the governing body of the Federation.

This Association's representatives on that Committee are Messrs. E. V. Evans and H. C. Smith, and Messrs. G. A. Mallett and J. Hunter Rioch, alternate members. Mr. R. W. Foot was appointed by the General Committee to be the Chairman of this National Body.

In May the Federation, in conjunction with the British Hard Coke Association, successfully negotiated with the Mines Department the establishment of a basic formula whereby, as and when there is an increase in the pithead price of coal, coke prices can be increased by a similar amount plus 50%.

National Solid Smokeless Fuels Efficiency Campaign

This is a recent development undertaken by the National Federation of Gas Coke Associations in conjunction with the British Hard Coke Association and the South Wales Anthracite and Dry Coal Committee, at the request of the Mines Department, who would otherwise have arranged their own campaign. The purpose of the campaign is to show consumers how they can use solid smokeless fuels more efficiently in present circumstances, and three consumers' brochures have been prepared dealing with (*a*) Domestic Boilers, (*b*) Central Heating Plants, and (*c*) Steam Raising Plants. All members have been asked to see that all their consumers are supplied with a copy of the brochure appropriate to their requirements.

In addition, there are three technical pamphlets on the same subjects for the use of staff who desire to give advice to consumers, or for consumers who have their own technical staff.

The cost of this work is being borne by the Gas Coke, Hard Coke, and Anthracite Organizations.

General Review of Association's Work

At the commencement of the war the services of the Association were placed at the disposal of the Mines Department. Two Government Orders, in particular, dealing with coke prices have been issued by the Department—namely, the Retail Coal Prices Order (for consumers' retail delivered business only) and the Wholesale Coal Prices Order (for consumers' contract business)—but it has been possible to maintain the Association's price scheme within the framework of these Orders. Throughout the Association's area there are five Divisional Coal Officers and 547 Local Fuel Overseers responsible for the carrying out of the Retail Coal Prices Order only. Quite recently the Local Fuel Overseers have been relieved of this responsibility and the work has been delegated to Assistant Divisional Coal Officers who have appointed Advisory Committees, representative of distributors, co-operative societies, colliery owners, coke producers, and consumers. The Association has a representative on each of these Committees.

The Association has been able to give assistance to all these in connexion with coke prices and with only few exceptions its prices have been scheduled for gas coke. Prices of coke *ex* gas-works do not come under any Order, but are covered by the pre-war assurance which the Industry gave to the Mines Department.

Very soon after the war it was found necessary to make application for an increase in the price of coke to compensate gas undertakings for the increased cost of coke manufacture. Unfortunately the granting of the application by the Mines Department was delayed until Nov. 20, 1939, when an increase of 3/4 per ton was made applicable to gas coke only. On Dec. 15, 1939, this was amended to 3/- per ton for deliveries of 10 cwt. and over, and 3/4 for deliveries of under 10 cwt. for all coke sold within the area (*i.e.*, gas and hard coke) ; and a further increase of 10d. per ton was allowed for coke delivered to consumers' premises. That gave distributors an increased margin of 10d. per ton on all their coke deliveries and a similar advantage to gas companies for coke delivered direct.

In May, 1940, a further application for an increase of 4/2 per ton on all coke sold within the area was made and granted, as from May 21, 1940. This was based on the increased cost of coal at the pithead and an average for the area of increased freight rates on coal inwards to gas undertakings, and increased freight rates on coke railed outwards.

Therefore, the total increases granted since the war are 7/2 per ton on coke sold *ex* works and stations, and 8/- per ton delivered, for deliveries of 10 cwt. and over, and 8/4 for deliveries of under 10 cwt. The 8/4 necessitated a " 5/9 cwt." column in the schedules to distinguish it from the 8/- on the ton prices and 5d. on the cwt. prices.

The co-operation with the Coke Producers' Federation and the Derby and Notts. Coke Producers' Association, reported in last year's report, has continued. In order that they might enjoy the same prices as those for local coke the Distributors' Tonnage Scale Certificate Scheme was evolved. A certificate (numbered and recorded) has now been issued to all distributors buying coke at contract rates. They are based on the tonnage of coke the distributor purchased from the local gas undertaking in the year 1937/38, except that the distributor has the right to appeal if his purchases were greater from another source. If no local coke were taken the certificate is based on his largest single contract with any other producer. Therefore, the rate shown on the certificate forms the minimum rate at which coke may be supplied. When the scheme has had time to function it is thought that it will be useful to all concerned.

The co-operation between the South Wales District (Coal Mines) Scheme, 1930, representing Welsh anthracite has also continued with much goodwill on both sides. Due to Government restrictions on prices it has not been possible to develop the price relationship between anthracite and coke as originally intended.

Notwithstanding the depletion of the staff of the Association's Technical Department, the development and maintenance work has been continued. Perhaps the most important is that undertaken in conjunction with the Ministry of Agriculture for the production of animal foodstuffs from domestic food waste. The Association has played an important part in getting plants into operation for this purpose. In the London area alone 300 tons per week of animal foodstuffs are being produced from household waste.

The work on appliances has been continued, but on a reduced scale, and the Approved Appliance list has been augmented as originally planned.

The Technical Committee have reduced their meetings to one every quarter instead of one per month, and this accounts for the reduced number of reports, although essential ones are being continued. It is regretted that the revision of the Technical Committee's 1933 Report, mentioned in the last Annual Report, has been delayed.

The Association will miss Mr. E. W. L. Nicol who died in April, 1940. Mr. Nicol had been Technical Adviser to the Association since its inception, and previous to that had worked for many years with the London Coke Committee. His life's work was devoted to the interests of coke utilization, and the results of his labour will continue to benefit the Industry.

Out of the Technical Staff, Mr. E. Brooks is serving with the Royal Artillery, and Dr. C. H. Noton and Mr. I. F. G. McVicker in the Ministry of Economic Warfare and in the Air Ministry respectively.

The Coke Distributors' Branch continues as an integral part of the Association, and the membership is well maintained.

The Association has lost during the year one of its loyal members in the death of Mr. W. W. Townsend. Mr. Townsend had been a member of the Central Committee since its inception and for several years was also a member of the Executive, Technical, and Finance Committees, and to each of these Committees he made many contributions. Mr. P. D. Walmsley, who died in March, was also connected with the Association since its inception, and will be greatly missed. He had been Coke Adviser for Norfolk for many years.

Special mention should be made of the good attendances at Committee Meetings during the war period. In spite of many difficulties all the meetings have been well attended.

Since the war began the Association has had many special difficulties to contend with, due principally to wartime conditions and wartime controls, and for these reasons it has been a particularly busy year for the Central and Executive Committees and for the Staff. In the opinion of the Central Committee, no praise is too high for the way in which the General Manager, the General Secretary, and the Staff of the Association have applied themselves to the altered and constantly changing circumstances, and have tackled successfully the many difficulties which have arisen.

Benham & Sons, Ltd.

A record net profit of £137,786 was announced by Mr. Stanley J. Benham, Managing Director, at the annual meeting of Benham & Sons, Ltd., in London on Jan. 30. The total turnover in 1940 was over £360,000 more than in 1939, which in turn was over £200,000 more than in the previous year. The chief increase was in the cooking apparatus department, which was responsible for more than half the turnover, but the Company had also had some very large heating contracts and other work for the Government. Nearly the whole of the output had been for the latter or for factories doing war work, and while the percentage of profit had again dropped, the total turnover had increased out of proportion to the increase in expenses. The meeting adopted the Directors' recommendation that £7,000 be added to reserve fund, now standing at £119,528, and that a final dividend be paid on ordinary shares at the rate of 5%, making 10%, plus a bonus of 2s., all less tax.

"Therefore we stand, all of us, upon the watch-towers of history, and have offered to us the glory of making the supreme sacrifices and exertions needed by a cause which it may not be irreverent to call sublime".

The Prime Minister.

Help our cause by saving & lending

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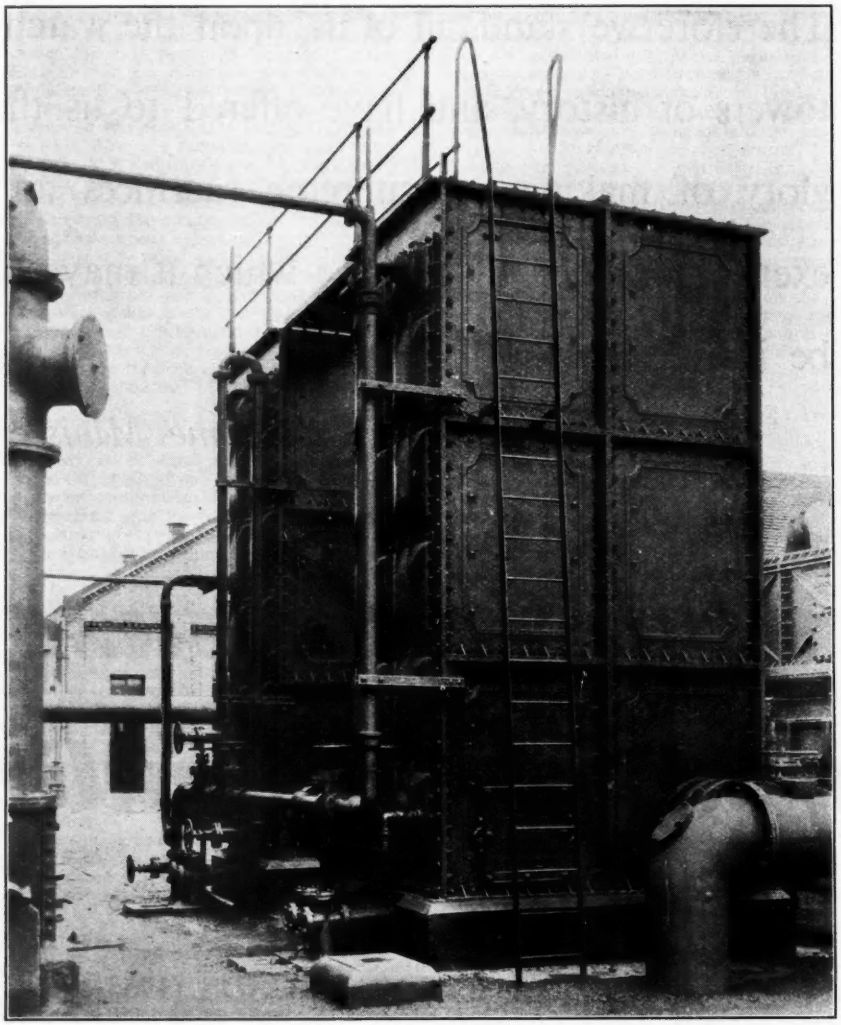

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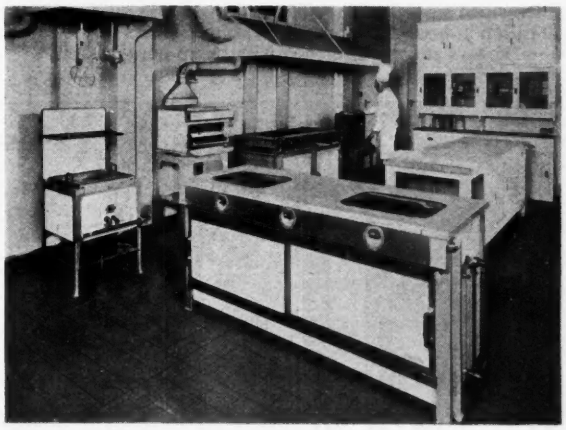
Holmes Gas Valves

To incorporate certain advantages both to the user and to assist manufacture, W. C. Holmes & Co., Ltd., Huddersfield, have redesigned their double faced "Western" valves, and have in consequence issued a new page for their Brochure No. 8 of "Holmes Gas Valves" to replace page 21, giving the principal weights and dimensions of the valves. The new valve is made in sizes 9 in. and upwards, except for the 48 in. size. The smallest sizes and the 48 in. size are still made on the old pattern. The main advantage of the new valve design is that the valve is now completely full bore, the gas way being unobstructed. The wedge piece at the base of the valve has been lowered out of the gas way and the bonnet on the valve has been deepened to allow the spindle to be kept clear of the gas way. While referring to W. C. Holmes & Co., Ltd., we might add that, to conform with the Government's request that paper consumption should be restricted, they have suspended the issue of their Holmes Calendar this year, but hope to resume the series on the cessation of hostilities.



The Leeds Gas Department have lately installed cooking equipment in a new hotel in the city, the dining room of which is capable of seating 200 persons. The gas apparatus, all in enamel finish, was supplied by Radiation, Ltd., and our photograph shows the attractive and businesslike appearance of the kitchen.

For Emergency Use

Cooking and heating must be carried on even when enemy action causes temporary interruptions in gas supply, and with that obvious fact in mind the Eagle emergency cooking and heating range No. 4 has been designed by the Eagle Range & Grate Co., Ltd., Aston, Birmingham, for use in the home, A.R.P. or Home Guard Posts, and for other needs. Constructed with cast-iron hob, firebox, front, and legs, sheet iron sides and back, oven sheet iron with cast-iron protection plate on top, and fitted with one runner and grid shelf and a cast-iron door with bakelite knob, the range is heated by ordinary household coal, and will heat up to 5,000 cu.ft. of room space. Cooking can begin from 10 to 15 minutes after lighting up, and temperatures are adjusted by a single control. All night burning can be achieved at minimum consumption by adding rough slack, and a three-course lunch for five persons can be cooked at a cost of ¾d. The cooker is portable, and all the fitting required is proper connexion to a suitable flue. Several of these units could be used for emergency cooking in a bombed area, and gas undertakings have been invited to take into stock a supply of these small ranges to meet either of the contingencies mentioned.

This striking "Ascot" gas water heater display was arranged at the end of last year in the window of the Wolverhampton Gas Company. Particularly effective by reason of its spaciousness and originality, the display attracted a good deal of local interest.

PATENTS

Scale Deposit in Water Heaters

Minimization of scale deposit in water heaters is the object of a patent (No. 526,349 ; application date, March 14, 1939), taken out by the Parkinson Stove Company, Ltd., and R. Hermann. The patentees point out that in districts having a hard water supply the efficiency of such heaters is liable to fall off very rapidly owing to the formation of scale or lime deposit on the surface of the shell in contact with the water. They claim that the rapid falling-off in the efficiency of a water heater is avoided by providing vertical gills or fins on the water side of the inner wall of the shell which carries the gills or fins heated by the burner.

When the heater is used with hard water lime tends to be deposited on the parts of the surface which are at the highest temperature and therefore the maximum deposit takes place on the surface between the gills or fins within the water way. As the thickness of the deposit increases less heat can be transferred to the water through these parts of the surfaces and more heat flows into the gills or fins and is transferred from them to the water.

Initially, they continue, no appreciable proportion of the total heat will pass through the gills or fins in the water way, as the heat conductivity between metal and water is very much higher than that between the gases from the burner and the metal, so that the part of the shell to which the gas heated gills or fins are secured is sufficient to transfer the heat to the water. When lime is deposited on the surface between the gills or fins they will gradually take over the heat transference, and the fall in the efficiency of the heater due to lime deposit will take place relatively slowly.

In one arrangement the fins secured to the inner wall of the water way are made from bi-metallic strip or sheet consisting of two metals having different coefficients of expansion so that under changes of temperature the fins will flex or bend and dislodge scale forming on them. The loosened scale will be carried off in the water as it flows through the heater, or will drop down into a position in which it does not affect the heat transmission or the flow of water.

Separating Tar from Tarry Sludge

Among recent patents is one (No. 526,143 ; application date, March 9, 1939) granted to the Woodall-Duckham Company, Ltd., E. Wallin, and H. M. Whitworth. It concerns the separation of tar from tarry sludge. It is pointed out in the specification that in coke-oven plants it is the custom to spray hot gas leaving the ovens with ammoniacal liquor. This causes the precipitation of a proportion of tar and liquor, which is drained from the gas-collecting main into a separating flushing tank. The tar and liquor separate in the flushing tank, the tar falling to the bottom, while the liquor is recirculated to the sprays in the gas offtakes. The tar and liquor entering the flushing tank have entrained therein a certain amount of fine coal and heavy sludge, which collects in the bottom of the tank, and must periodically be removed therefrom. This sludge has a proportion of useful tar which it is desirable both to recover for its own value before the sludge is disposed of, and to remove in order to facilitate disposal of the sludge.

The objects of the invention are to provide a convenient and clean method of, and apparatus for dealing with the tarry sludge in order to dispose of it, and to separate the entrained tar from the sludge.

According to the invention, tar is separated from the sludge collecting in the flushing tank and the sludge is disposed of, by the following sequence of steps : The tarry sludge from the tank is drained into a separating tank rotatable about a horizontal axis, the contents of the separating tank are subjected to heat to cause a separation of the tar, the separated tar is drained off, and the separating tank is then tilted on its axis, to facilitate the removal of the residual sludge. The apparatus comprises a separating tank having one side sloping, and mounted for tilting about a horizontal axis, into which separating tank the sludge from the flushing tank can be drained, with a tar manifold having outlets from the separating tank at spaced levels. Means are provided to heat the contents of the separating tank, the sloping side of the separating tank forming, when the tank is tilted, a substantially horizontal platform over which residual sludge is scraped or discharged into receptacles.

EXPERIENCE WITH IGNITION DOME CARBURETTOR USING HEAVY OIL*

By LEO ALBERT

Engineer, City of Norwich (Conn.) Gas and Electrical Department

IN 1938 it became evident to us that it would be necessary to take drastic steps to decrease production costs at our plant. This necessity was dictated by the fact that raw materials were on an upward price trend, our light tar market was falling off, and our output of gas for industrial purposes was on the uptrend. All of these factors combined made it imperative that careful consideration be given to the use of Bunker "C" Oil for enrichment purposes.

Inasmuch as we had adequate storage capacity for finished tar, a tar dehydrating plant, and sufficiently large tar separators, the problem was fairly simple. The problem of heavy tar disposal presented no difficulties as we have a combination oil-fired and waste-heat boiler. Unless we could get an attractive price for our heavy tar we were prepared to use the heavy tar as a fuel in our boiler.

From our study of the problem it was decided to convert our 7 ft. 6 in. standard backrun gas machinery set to the use of heavy oil by the installation of a Semet-Solvay ignition dome. Work was begun on this change in October, 1938, and the set was put into service early in December of the same year.

Description of Changes to Set

An Anthony water-cooled oil spray was installed in the generator dome, set so as to spray oil obliquely down on the fire, and so located as to be easily accessible from the operating floor.

All checkers were removed from the carburettor and an ignition dome was installed. The ignition dome is most simply described as a 9 in. thick, flat, annular section built at right angles to the vertical axis of the carburettor at a point level with the bottom of the generator-carburettor connexion. The round opening in the centre of the dome is flared toward the bottom of the carburettor from a diameter of 24 in. at the top face of the dome to a diameter of 36 in. at the bottom face. On the top face of the dome four brick piers were placed, extending to the underside of the main carburettor dome. The purpose of these piers is to break up the flow of the blue gas from the generator, and direct it through the nozzle in the dome.

An Anthony water-cooled oil spray was installed in the centre of the carburettor 3 ft. above the carburettor bottom. This spray directs the oil upward in the carburettor, counter-current to the blue gas. The spray is easily removed through the side of the carburettor shell for cleaning.

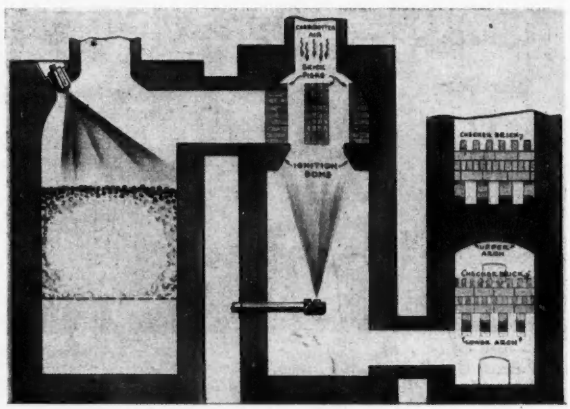
An additional clean-out door was installed at the bottom of the carburettor to facilitate the removal of accumulated carbon. The carburettor air is admitted through the top of the carburettor dome and is controlled by a creeper valve.

A new set of arches was installed in the superheater, located 3 ft. above the existing arch blocks. The bulk of the superheater checkers are therefore supported on the upper arches, while only four rows of checkers are placed on the lower blocks. In this manner the first four rows of checkers take the bulk of the carbon deposit, and can easily be replaced when necessary without disturbing the remainder of superheater checker brick. We have removed old checkers and replaced new checkers in this lower section in the ordinary course of generator clinkering shut-down periods.

A cone bottom addition was made to the existing wash-box for the purpose of more easily handling any accumulations of heavy tar. We feel that this additional investment was well worth while, as we have been able to keep ahead of any accumulations of tar which would lead to annoying consequences.

Five additional sprays were installed in the three-way valve assembly, and one each in the backrun connexion and superheater connexion to the three-way valve. The use of these sprays has contributed much to keeping heavy accumulations out of the three-way valve assembly.

A 50,000 gallon tank is used for the storage of Bunker "C" Oil ; and through the use of vertical banks of coils and exhaust steam, the oil is heated to 120°F. at the outlet of the tank. This is sufficiently hot to allow for easy handling by the pumps. From the Bunker "C" pumps, the oil passes through a primary heater which heats the oil to about 275°F. This oil is stored in a 100 gallon hot-oil tank from which point it enters the oil sprays. All oil sprays are also equipped with steam purge units.



Ignition Dome Carburettor.

Gas Making Materials

Bunker "C" Oil having the following approximate analysis is used :

Gravity	14 A.P.I.
Flash Point	200° (plus).
Viscosity	55 Sec. @ 122°F.-S.F.
Conradson Carbon	9.1%.
Pour Test	30°F.
B.Th.U. per Gall.	152,000.

Coke—Dry Basis :

B.Th.U per lb.	13,550	
Fixed Carbon		91.22%
Ash		7.11%
Volatile		1.67%
		100.00%
Size	Stove	
Type	Vertical coke oven.	

Operating Cycle—20% Reforming :

Uprun—120 seconds.
Uprun Oil 80–90 sec. admission time.
Backrun—80 seconds.
Reform Oil 35 sec. admission time.
Uprun Purge—10 seconds.
210 seconds total running time.
Blow-down—(0–10 sec.) adjusted to maintain 0.63 gravity.
Average blowing time 2.4 minutes.

Operating Procedures

Due to the fact that we have ample gas storage capacity, it is only necessary for us to run an average of 12–13 hours per day. At times it has been possible to run two days without clinkering

* Presented before New England Gas Association, Operating Division.

the generator, but as a rule the generator is clinkered every morning. The clinkering time varies from 60–90 minutes.

Carbon deposits vary with the type of oil used. With a 9.0% carbon oil very little trouble is experienced with carbon deposits in the carburettor. We can keep ahead of large deposits by cracking the lower door in the carburettor and opening a vent in the top of the carburettor air inlet tee. This procedure allows a draught of air to pass up through the carburettor during the shut down period and effectively burns out a large proportion of the carbon on the walls. About every third day the carbon is removed from the bottom of the carburettor. We have found that by sprinkling coke on the carburettor bottom it is much easier to remove the carbon. The coke prevents the carbon from sticking tightly to the bottom, and the carbon can easily be broken out with bars.

Operating period		Coke per 1,000 cu.ft.	Bunker "C" Oil per 1,000 cu.ft.	Per cent.	Average Hourly Make	Steam: Up-steam pounds	Steam: Back-steam pounds	Pounds per 1,000 cu.ft.
Months.	Hrs.	Lb.	Gals.	Reform.	1,000 cu.ft.	per min.	per min.	Made.
11	3,200	18	4.45	24%	55	58	41	32
10	2,500	20	4.00	15%	55	58	41	32

The carburettor oil spray is removed once a week and thoroughly cleaned. We have found it necessary to remove the generator spray only once in three months, on the average. The three-way valve and its connexions are cleaned after each operating day. The wash-box and seal pot are flushed out every day.

Our set maintenance, as far as refractories is concerned, has been materially decreased through the use of the checkerless carburettor and the installation of the arch in the superheater. The four rows of checkers in the bottom are designed to take the bulk of the carbon carried over, but we have found but very little carbon deposit on these brick. The principal cause for removal is that their heat absorption property has been destroyed. We have found that approximately 20% longer life has been obtained from the superheater checkers due to the arch installation in the superheater.

Conclusions

The installation of the ignition dome and the use of heavy oil has increased our production capacity from 48,000 cu.ft. per hour to 55,000 cu.ft. per hour. It is possible to increase this capacity by 5,000 cu.ft. per hour if we were not limited by the available capacities of the auxiliaries.

The quality of the Bunker "C" oil used is a critical factor in obtaining maximum results. In our particular case an oil containing over 9.1% carbon causes increased carbon deposits in the carburettor.

After two years' experience with the ignition dome we feel that it has satisfactorily fulfilled expectations, with a minimum investment.

THE INSTITUTION OF GAS ENGINEERS

SECOND ARTHUR DUCKHAM RESEARCH FELLOWSHIP REPORT*

The Radiation from Solid Substances Under Flame Impact: Part 1

[Communication No. 237]

(*Continued from p. 205*)

Subsequently, in a discussion on the influence of the mode of heating, the following rather surprising statement was made:

> "The type of luminescence now under consideration, unlike the luminescence by flame excitation described in a previous section, is not confined to substances exposed to the action of the hydrogen flame. It is, for example, possible to see the blue glow when beryllium oxide is heated in a crucible, or when zinc oxide or other oxides are heated on a strip of platinum foil. The effect is, however, much more intense when the flame is used, and the brightness is greatly affected by changes in the supply of oxygen so slight that the actual temperature, as indicated by the radiation from the black surface, is not appreciably modified."

The latter statement was considerably amplified, and it was pointed out that the radiation from certain substances is subject to very considerable modification according to whether oxygen or hydrogen was in excess in the flame.

The chapter following was concerned with "transformation spectra", i.e., the light emitted by beads of molten salts on heating to or cooling from incandescence. Except that there are some relations between emission of this type and that observed in "candoluminescence", the work is not directly related to the subject under discussion. Finally, a general discussion was given of the relation of "candoluminescence" to other forms of luminescence. It was shown that effects due to fatigue and heat treatment are similar, while spectrometric analysis of the "candoluminescent" emission of many substances showed "submerged components" in the apparently continuous emission which were identical in various forms of luminescence. Attention was also drawn to the effect of "activators" in modifying the emission from incandescent substances, and curves given for pure aluminium oxide and the synthetic ruby, i.e., aluminium oxide plus a trace of chromium, and for fluorite containing certain rare earths.

* Research Fellow, E. C. W. Smith.

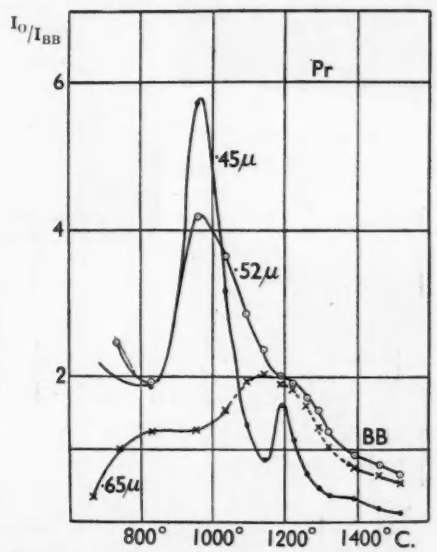
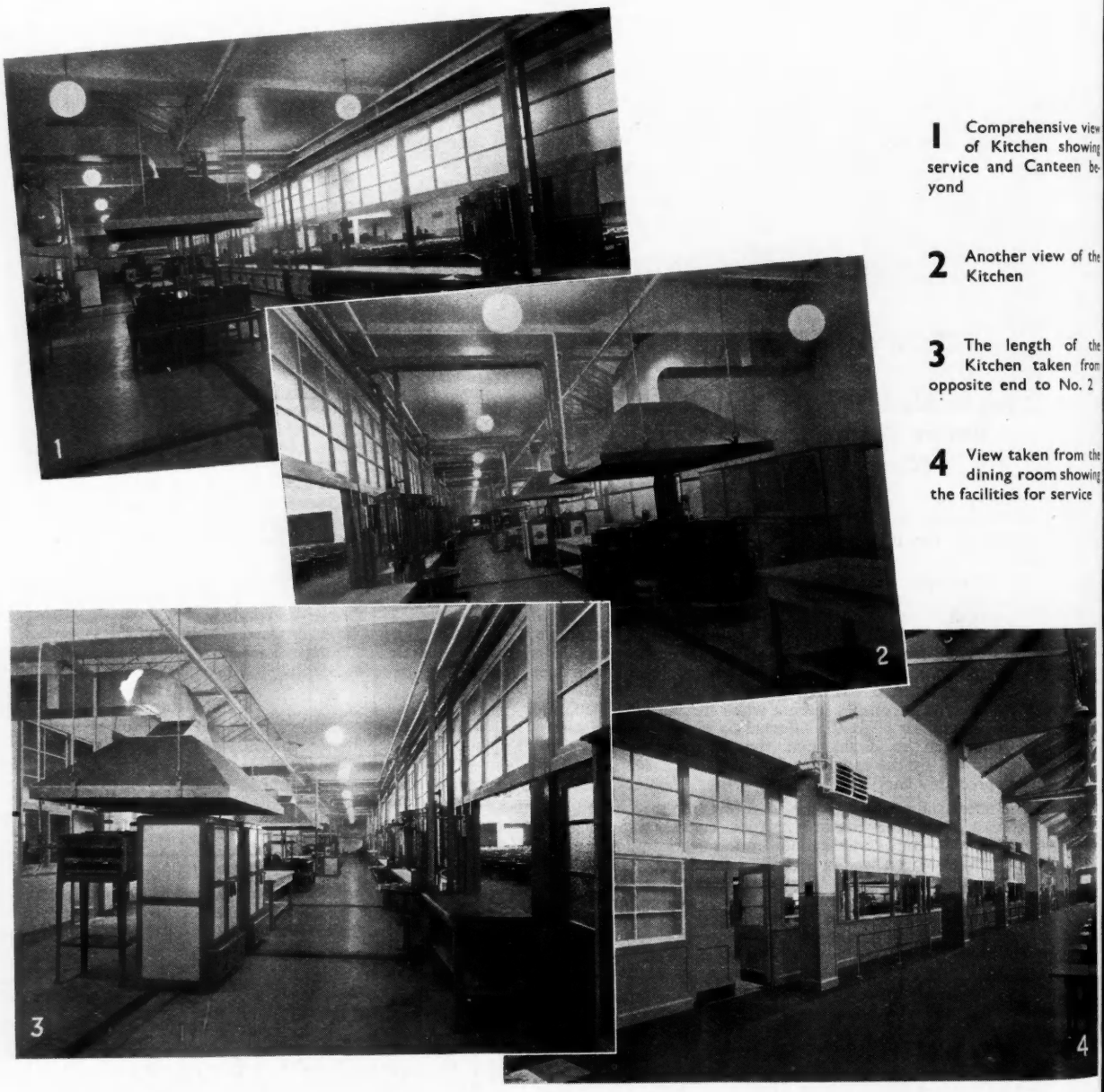


FIGURE 3.—*The Abnormal Emission from Praesodymium Oxide, as given by E. L. Nichols*[14]. *The Curves show the Variation with Temperature of the Ratio* I_O/I_{BB} *at Various Wave-Lengths.*

The curves given for the aluminium oxide and the synthetic ruby are reproduced in Figure 4.

An account of extended work on activators in candoluminescence appeared in a paper published by Nichols and L. J. Boardman in 1930[15]. The luminescence of thoria below 800°C. is described (this substance had been previously listed as inactive). Using a technique similar to that employed in the earlier experiments, the heating of an unactivated oxide, an activated oxide and a black body in a symmetrically disposed flame, it was claimed that the activated oxides show ratios of I_O/I_{BB} which are quite different from those of the unactivated substances. Experiments with a great variety

LARGE SCALE



1 Comprehensive view of Kitchen showing service and Canteen beyond

2 Another view of the Kitchen

3 The length of the Kitchen taken from opposite end to No. 2

4 View taken from the dining room showing the facilities for service

The illustrations above show Radiation appliances in the Canteen Kitchen of a large factory engaged on war work.

COOKING—

TECHNICAL and other problems connected with the planning and equipping of Hospital, Hotel and Industrial Canteens and Kitchens are the constant study of the Radiation Large Cooking Equipment Section.

Canteens and Kitchens are being equipped in all parts of the country and the illustrations on facing page will give an idea of the size of some of these installations.

Knowledge and experience, coupled with unrivalled designing and manufacturing facilities, ensure in advance the right practical approach to every project. Many of the most successful Canteens are evidence of this Radiation care and forethought and of their skilled assistance to Gas Undertakings in the carrying out of such work.

Radiation

RADIATION LTD.

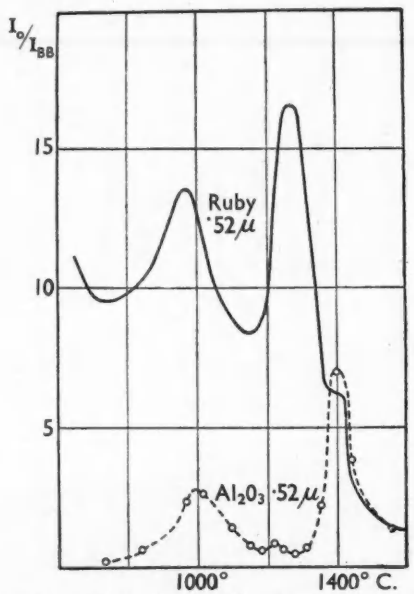


FIGURE 4.—*The Effect of a Small Amount of Chromium on the Emission from* Al_2O_3 *as given by E. L. Nichols*[14]. *(The "ruby" is a Synthetic Product made by adding a trace of Chromium to* Al_2O_3 *with subsequent heat treatment.)*

of solid solutions of beryllium, manganese and rare earth oxides in aluminium, beryllium and calcium oxides were also described.

Another paper by Nichols and Howes[19] in 1932 gave similar results for a number of mixtures of rare earth oxides. It was claimed that the location of the maxima in the I_o/I_{BB}—temperature curves is characteristic of the activators employed.

The similarity between ultra-violet, cathode ray, thermo-luminescence after exposure to ultra-violet light and candoluminescence at low temperature was the subject of a further publication by Nichols and F. G. Wick in the same year[20]. The cases of calcium, praesodymium and various rare earth oxide mixtures were then discussed.

This aspect of the problem was still further developed by F. G. Wick and C. G. Throop in 1935 [21]. They determined the optimum concentration of praesodymium, samarium and terbium in thorium oxide for the excitation of luminescence under the influence of cathode rays, ultra-violet light and the hydrogen flame. It was found that the optimum concentration in each case was different for each exciting source, and was always lowest for cathode-ray excitation.

It is important to note that in contradiction of all this work F. Skaupy and G. Liebmann[22] have examined the emissivity of various oxides, heated both electrically and by the flame, without discovering any abnormality.

V. DISCUSSION OF PREVIOUS RESULTS

This summary of the state of knowledge relating to the subject of "candoluminescence" may be regarded as comprehensive. There are other references to the subject in the literature, while the field is mentioned in some standard text books, but omitted entirely in others, doubtless because the experimental evidence is in many of its aspects not entirely satisfactory. This applies particularly in the high temperature ranges in which luminescence is considered to supplement thermal emission. It is quite certain that, in accordance with the reasoning given on p. 9, the supposition made by Nichols and his collaborators that the temperatures of the black and white oxide layers were identical is unsound, unless the thermal contact between the two is so good that the difference in the specific infra-red emissivity is ineffective in controlling the temperature of each layer. On the other hand, although the assumption of a considerable difference in temperature would explain the high values of I_o/I_{BB} observed it would not appear to furnish an explanation of the complicated temperature dependence of this ratio, and in particular of the fairly sharp maxima in the curves. These can only be accounted for by an abrupt change in either the infra-red emissivity or the thermal conductivity of the substances concerned. In this respect, it is important to note that Nichols has observed that some of the maxima coincide with breaks in the electrical conductivity-temperature curves of the substances in question.

The so-called "fatigue" effects are not inconsistent with a purely thermal explanation; continued heating will raise the temperature of the lower layers of the emitting substance and of its refractory support, this leading to an increase in the thermal conductivity of the materials, and hence to a greater heat loss and a lower surface temperature. At the same time, permanent changes in emissivity or thermal conductivity may be brought about by continued heating, due either to chemical or crystal structure changes, thus providing an explanation for the permanent effect of previous heat treatment.

The variation with temperature of the apparent colour of the emitted radiation may be explained by the temperature shift of the characteristic absorption of the material. This point has been examined for the case of zinc oxide by J. H. Gisolf[23] and shown to provide an explanation of the characteristic green colour of the heated oxide.

The behaviour of activators is not inconsistent with a purely thermal explanation, on the basis of the generally-accepted theory of the Welsbach mantle.

VI EXPERIMENTAL

It was considered advisable in the first place to investigate the supposed luminescence in the higher temperature ranges which had been thought to supplement the normal thermal radiation, since this seemed more likely to prove of practical importance. For it will be remembered that while in the lower temperature ranges approaching red heat, the ratio I_o/I_{BB} was given values of the order of 500, the actual value of I_o was very small, i.e., the intrinsic brightness of the purely luminescent sources was very low, although the indications were that the overall efficiency of light production might be high.

A repetition of some of Nichols's experiments was first carried out, using a number of pure oxides, including those of beryllium, zinc, aluminium and thorium. The oxide under test was thinly coated on the surface of an alundum block, and a layer of uranium oxide to serve as a "black body" placed immediately adjacent to it. The two were then heated together by an oxy-hydrogen flame from a specially-constructed blow-pipe placed symmetrically with respect to the two oxide surfaces. The blow-pipe was provided with jets of fused silica, in order to prevent the colouration of the flame by material from the jet. The temperature attained by the surfaces could be varied by adjustment of the hydrogen and oxygen supply to the blow-pipe and observations of the apparent temperature were made by means of a Foster optical pyrometer.

The results may be summarized by the statement that qualitative agreement was found with the measurements of Nichols. Thus, when the ratio I_o/I_{BB} was plotted against temperature, the resulting curves had the same general form as those given by Nichols, the curves rising to maxima whose location with respect to the temperature axis was in accord within probable experimental error, with that given by Nichols. The absolute magnitude of the I_o/I_{BB} ratio, however, was not constant with different specimens; this is itself in accord with the finding of Nichols, as he stated that the magnitude of the crests was very dependent on the previous history of the specimen.

Having thus ascertained that the measurements of Nichols were reproducible, it was necessary to determine whether the apparently greater light emission of the "candoluminescent" substances was actually a luminescence, or whether the temperature was in fact much higher than that of the uranium oxide comparison radiator. The direct measurement of the temperature of such an emitting surface is a matter of very great difficulty. The point at issue could be decided by making measurements of the absorbtivity of the material for various wave-lengths throughout the required temperature range, and simultaneously determining the apparent brightness for the same wave-lengths. Then, from the theory explained on p. 7, it would be possible to compute the brightness for any temperature and wave-length from the absorbtivity measurements, and compare the values so obtained with those directly measured. Unless the luminescent radiation happened to have a spectral distribution precisely corresponding with the black body laws, which is extremely improbable, any abnormality would then be at once apparent. On the other hand, such measurements require special apparatus, and the technique would be diffi-

cult to apply in the present case. Hence it was decided to attempt the determination of the surface temperature by measuring directly, by means of extremely fine thermocouples, the temperature immediately below the surface, and finding a relation between the temperature so measured and the true surface temperature.

In the first series of experiments it was desired merely to ascertain whether a large difference in temperature between the black and white oxide surfaces actually existed, under the conditions of Nichols's experiments. An alundum block of the form shown in Figure 5 was made by pressing damp alundum cement in a suitable mould, and subsequently drying and firing. The surface of the circular depression was coated half with uranium oxide and half with the substance to be tested, e.g., beryllium oxide, in the manner illustrated, and a thermojunction between platinum and platinum + 10 per cent rhodium wires, of 0·001 in. diameter, arranged to hang symmetrically in contact with the surfaces. The thickness of the two coatings was then increased by painting on a suspension of the appropriate oxide until the thermojunctions and their component wires were just covered. In some instances it was necessary to use a trace of sodium silicate in the suspension in order to secure oxide layers which were sufficiently adherent.

Preliminary experiments showed that if the thermocouple wires were fixed to the support at both ends, then on heating the expansion of the wire was sufficient to break the coatings. The simple arrangement shown in which the wires were tensioned by small weights subsequently proved satisfactory. The oxides were heated as in the previous experiment by a symmetrically disposed oxy-hydrogen flame, the temperature again being regulated by the position of the flame and adjustment of the hydrogen-oxygen ratio. After the system had reached equilibrium at a particular temperature, measurements of the temperature of the black and white oxides were made by means of both the optical pyrometer and the thermocouples. The temperature of the black oxide, as determined by the thermocouple, was rather lower than that recorded by means of the optical pyrometer, the difference in value obviously depending mainly on the thickness of the coating; in general it ranged between 50° and 150°C. It was to be expected that the difference between the surface temperature of the white oxide and that measured by the couple embedded in it would be of the same order, and the results obtained showed that, within the experimental error, the temperature of the white oxide surface was always greater than that indicated by the optical pyrometer. Even more significant was the fact that a large difference, amounting to as much as 200°C., was observed between the readings from the two thermocouples, under conditions where Nichols had assumed the temperatures of the two surfaces to be equal. This was in itself sufficient to show qualitatively that the apparently abnormal emissivities observed by Nichols were in fact to be ascribed to an error in the estimation of the temperature, but the difficulties of the method, in particular the uncertainty with regard to the thickness of the coating above the couple, made it impossible to derive either a theoretical or empirical treatment of the problem adequate to furnish a reliable value for the emissivity. The following table shows two runs which are typical of the results obtained:

Uranium Oxide		Beryllium Oxide	
To, °C.	Tc, °C.	To, °C.	Tc, °C.
1	2	3	4
902	895	1,071	1,115
911	900	1,069	1,110
1,000	960	1,125	1,165
1,089	1,055	1,156	1,197
1,180	1,122	1,303	1,332
1,250	1,150	1,391	1,373
1,290	1,373	1,470	1,425
953	903	973	972
1,001	950	1,051	1,038
1,122	1,085	1,170	1,110
1,250	1,165	1,276	1,172
1,352	1,230	1,391	1,265
1,471	1,332	1,432	1,470

To = Temperature as measured by optical pyrometer.
Tc = " " " by thermocouple.

(*Continued on p.* 256)

Has your Gas Pressure been affected as a result of enemy action?

The effects of enemy action may often be countered, and a supply of gas be assured at some lower-than-normal pressure. In these circumstances, injector nipples may require more than their normal maximum output to give a satisfactory service, and careful enlargement may be called for.

We can still supply our **FORSHAW'S CALCULATOR**, which enables the user to determine the effect on gas consumption of pressure, specific gravity, orifice size, and orifice coefficient.

Enclosed with each Calculator, in a stout manilla container, is a leaflet which fully explains the use of the various scales, and, in addition, gives a number of working examples. The container measures 6 in. × 5¾ in.

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The Calculator consists of four circular scales which denote pressure in tenths or inches water gauge; consumption in cubic feet per hour; specific gravity of gas; the sizes of twist drills in morse numbers or letters, and in sixty-fourths of an inch. Two pointers, which are used in conjunction with the scales, allow the effect of specific gravity and of orifice coefficient to be determined. Readings can be quickly made to the degree of accuracy associated with a 12-inch slide rule.

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MAIN

Gas Products Prices

The London Market

Feb. 3.

The prices of Tar Products in the London market remain to-day as under : Pitch is nominal ; creosote 4¼d. to 5d. per gallon ; refined tar 3¾d. to 4d. ; pure toluene under the Ministry of Supply Toluene No. 2 Order is 2s. 5d. ; pure benzole is 1s. 10d. ; 95/160 solvent naphtha 2s. 3d. ; and 90/160 pyridine about 15s. 0d. ; all per gallon naked ; refined crystal naphthalene £23 per ton in bags ; all *ex* Makers' Works.

The Provinces

Feb. 3.

The average prices of gas-works products during the week were : Pitch and Crude Tar,* Toluole, naked, North, 1s. 10d. (controlled by the Control of Toluene No. 2 Order, July 5, which fixes the maximum price at which this material may be sold). Coal tar, crude naphtha, in bulk, North 9½d. to 10d. Solvent naphtha, naked, North, 1s. 9d. to 1s. 10d. Heavy naphtha, North, 1s. 5d. to 1s. 6d. Creosote, *ex* works, in bulk, North liquid and salty, 4¼d. to 4¾d. ; Scotland, 4¼d. to 4¾d. ; low gravity, 4¼d. to 4¾d. Fuel Grade 4d. to 4¼d. Carbolic acid, 60's, 3s. 9d. to 3s. 10½d. Naphthalene, £15 to £20. Salts, 75s. to 85s., bags included. Anthracene, "A" quality, 4¼d. to 4¾d. per minimum 40% purely nominal. Heavy oil: Unfiltered anthracene oil (min. gr. 1,080), 5¼d. to 5¾d. ; filtered heavy oil (min. gr. 1,080), 5¾d. to 6d. ; heavy anthracene oil gr. less than 1,080, 6d. to 6¼d.

* In regard to pitch and crude tar prices we would ask readers to refer to the editorial note in our issue of Sept. 4, 1940, p. 404.

Tar Products in Scotland

GLASGOW, Feb. 1.

Quietly steady conditions prevail in this district with production well looked after.

Refined tar is only moving in small quantities, principally for export, with prices unchanged at 4½d. to 4¾d. per gallon in the home market and 3¼d. to 3½d. per gallon for export, both f.o.r. naked.

Creosote oil continues in good demand with all grades firm as under : Specification oil, 5d. to 5¼d. per gallon ; low gravity, 6d. to 6½d. per gallon ; neutral oil, 5¾d. to 6d. per gallon ; all *ex* Works in bulk.

Cresylic acid is still dull with prices showing no alteration as under : Pale, 99/100%, 2s. to 2s. 2d. per gallon ; Pale, 97/99%, 1s. 9d. to 1s. 10d. per gallon ; Dark, 97/99%, 1s. 6d. to 1s. 7d. per gallon ; all *ex* Works in buyers' packages.

Crude naphtha finds a ready outlet at 6½d. to 7½d. per gallon *ex* Works in bulk, according to quality.

Solvent naphtha continues quite active at 1s. 8½d. to 1s. 9d. per gallon for 90/160 grade and 1s. 4½d. to 1s. 5½d. per gallon for 90/190 heavy naphtha.

Pyridine.—In the absence of business, prices are nominal at about 17s. to 18s. per gallon for 90/160 grade and 19s. to 20s. per gallon for 90/140 grade.

Dividend Announcement

Newcastle-upon-Tyne

The Directors of the Newcastle-upon-Tyne & Gateshead Gas Company have approved payment of final dividends for the year ended Dec. 31, 1940, as follows :

£2%, less tax, on the Preference Stock, making £4% for the year.

£2 17s. 6d.%, less tax, on the Ordinary Stock, making £5 7s. 6d. % for the year.

The rate of ordinary dividend for the year is the same as for last year.

A.R.P.

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GAS STOCKS AND SHARES

Apart from a few occasional bursts of activity the general conditions on the Stock Exchange last week remained quiet and dull. The values of British Funds were well maintained, however, and 2½% Consols closed at the previous week's level of 77½. Very little business was done in home rails, although, after being under a cloud for some time, a few of the junior stocks showed a tendency to harden. Industrials were irregular and any price movements unimportant. Oils firmed up a little towards the close and there were more inquiries for tea shares. Apart from a few specialities the mining market was neglected.

More transactions were recorded in the Gas Market than for the past few weeks, although with few exceptions quotations remained unaltered. In the Official List it will be seen that on a narrowing of the margin South Metropolitan ordinary finally closed fractionally higher, and a few minor changes occurred among the fixed interest stocks. On the Provincial Exchanges the only fall of note was the drop of 1½ in Bristol ordinary to 90.

Dividend announcements are now beginning to come in, and it is satisfactory to note that among the first appears that of the Cardiff Company, which has increased its final distribution to 3%, against £2 13s. for 1939, making 6% for the year. The Oxford and District Company are maintaining a final of 5%, making 10% for the year (the same), and the net profit is returned at £54,480 as compared with £41,885 for 1939.

Quotations on the London and Provincial Stock Exchanges

OFFICIAL LIST

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Jan. 30.	Rise or Fall on week.
1,767,439	Sept. 16	7	7	Alliance & Dublin Ord. ...	103—108	...
374,000	Dec. 30	4	4	Do. 4 p.c. Deb. ...	90—95	...
957,608	Nov. 4	5	5	Asscd. Gas & Water U'd'ts Ord.	11/6—13/6	...
500,000	,,	4½	4½	Do. 4½ p.c. Red. Cum. Pref.	14/6—16/6	...
535,545	,,	4	4	Do. 4 p.c. Red. Cum. Pref.	14/6—16/6	...
336,646	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	12/—14/-	...
561,370	Aug. 12	7	7	Barnet Ord. 7 p.c.	97—102	—1
300,000	Oct. 14	1/9⅜	1/4⅜	Bombay, Ltd.	19/6—21/6	...
690,407	Aug. 19	7	7	Bournemouth 7 p.c. max. ...	105—115	...
362,025	Dec. 16	4	4	Do. 4 p.c. Deb. ...	79—84	...
659,955	Aug. 19	6¾	4⅜	Brighton, &c., 5 p.c. Con. ...	65—75	...
855,000	Sept 30	8	6	Brit. Gas Light Ord.	75—85	...
545,000	Dec. 16	5½	5½	Do. 5½ p.c. 'B' Cum. Pref	105—115	...
120,000	,,	4	4	Do. 4 p.c. Red. Deb.	73—78	...
10,000	Nov. 6, '33	6	4	Cape Town, Ltd., 4½ p.c. Cu. Pf.	¼—1	...
626,860	July 15	5⅝	6	Cardiff Con. Ord.	89—94	...
24,500	Sept. 23	7	7	Colombo 7 p.c. Pref.	19/—21/-	...
764,169	Oct. 7	-/11.48	-/11.48	Colonial Gas Assn. Ltd. Ord. ...	14/—16/-	...
400,000	,,	1/3.30	1/3.30	Do. 8 p.c. Pref. ...	19/—21/-	...
1,748,935	July 22	2	3	Commercial Ord.	35—40	...
620,000	Dec. 9	3	3	Do. 3 p.c. Deb.	57—62	...
286,344	Aug. 19	5	5	Do. 5 p.c. Deb.	87—92	...
807,560	Aug. 12	7	6	Croydon sliding scale	83—88	...
644,590	,,	5	5	Do. max. div.	75—80	...
620,385	Dec. 30	5	5	Do. 5 p.c. Perp.Deb. ...	90—95	...
179,500	Aug. 19	5⅝	5	East Surrey 'B,' 5 p.c.	60—70	...
176,461	Dec. 16	5	5	Do. 5 p.c. Deb. (Irred.)...	87—92	...
250,000	Nov. 11	4	6	Gas Consolidation Ord. 'B' ...	13/6—14/6	...
250,000	Nov. 11	4	4	Do. 4 p.c. Red. Cum. Pref.	15/—17/-	...
19,123,018	July 29	3⅜	4½	Gas Light & Coke Ord. ...	12/—14/-a	...
2,600,000	,,	3½	3½	Do. 3½ p.c. max.	45—50	—2
4,477,106	,,	4	4	Do. 4 p.c. Con. Pref. ...	67—72	...
2,993,000	July 8	3¾	3¾	Do. 3¾ p.c. Red. Pref. ...	82—87	...
8,602,497	Dec. 2	3	3	Do. 3 p.c. Con. Deb. ...	69—74	...
3,642,770	,,	5	5	Do. 5 p.c. Red. Deb. ...	100—105	...
3,500,000	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	99—104	...
700,000	Sept. 9	3½	3½	Do. 3½ Red. Deb. ...	80—85	...
5,600,000	May 13	4	8	Imperial Continental Cap. ...	44—49	...
43,820	Jan. 27	3½	3½	Do. 3½ p.c. Red. Deb. ...	62—67*	+1
231,978	Aug. 19	5	5	M.S. Utility 'C' Cons.	68—73	...
918,657	,,	4	4	4 p.c. Cons. Pref.	72—77	...
675,000	Nov. 11	†4	†4	Montevideo, Ltd.	52—57	...
300,000	Nov. 18	7	9	Oriental, Ltd.	105—115	...
368,537	Dec. 9	8	6½	Plymouth & Stonehouse 5 p.c.	88—98	...
621,667	Aug. 19	8⅛	7½	Portsmouth & Gosport Cons.	90—95	...
648,999	Sept. 16	1/1	1/1½	Severn Val. Gas Cor. Ld. Ord.	13/—15/-	...
597,972	,,	-/10⅝	-/10⅝	Do. 4½ p.c. Cum. Pref. ...	15/6—17/6	...
2,528,714	Sept. 2	1/-	-/7½	South East'n Gas Cn. Ld. Ord.	8/—10/-	...
1,000,000	,,	-/10⅝	-/10⅝	Do. 4½ p.c. Red. Cum. Pref.	14/—16/-	...
1,068,869	,,	4	4	Do. 4 p.c. Irred. Cum. Pref.	12/6—14/6	...
4,709,895	Aug. 5	4	4	South Met. Ord.	43—48	+½
1,135,812	,,	6	6	Do. 6 p.c. Irred. Pref. ...	102—107	...
850,000	,,	4	4	Do. 4 p.c. Irred. Pref. ...	69—74	...
1,895,445	Dec. 30	3	3	Do. 3 p.c. Perp. Deb. ...	58—63	...
1,000,000	Jan. 15	5	5	Do. 5 p.c. Red. Deb. ...	97—102	...
1,543,795	July 22	3	4	South Suburban Ord. 5 p.c. ...	62—67	...
512,825	July 8	5	5	Do. 5 p.c. Perp. Pref. ...	85—90	...
500,000	,,	4	4	Do. 4 p.c. Perp. Pref. ...	63—68	...
250,000	,,	3½	3½	Do. 3½ p.c. Red. Pref. ...	80—85	...
888,587	Dec. 16	5	5	Do. 5 p.c. Perp. Deb. ...	93—98	...
750,541	Aug. 9	5½	5	Southampton Ord.	57—62	...
350,000	Feb. 12	5½	5½	Swansea 5½ p.c. Red. Pref. ...	91—96	...
1,076,495	Aug. 5	5	5	Tottenham & District Ord. ...	62—67	...
338,555	,,	5	5	Do. 5 p.c. Pref.	78—83	...
453,380	Dec. 9	4	4	Do. 4 p.c. Perp. Deb. ...	76—81	...
1,247,505	May 20	4	6	U. Kingdom Gas Cor. Ord. ...	13/—15/-	...
1,085,952	Nov. 25	4½	4½	Do. 4½ p.c. 1st Cum. Pref.	13/6—15/6	...
772,709	,,	4	4	Do. 4 p.c. 1st Red. Cum.Pref.	13/—15/-	...
745,263	Dec. 16	4½	4½	Do. 4½ p.c. 2nd Non.Cum. Pf.	12/—14/-	...
1,200,000	Sept. 9	3½	3½	Do. 3½ p.c. Red. Deb. ...	84—89	+2
380,606	Aug. 5	7	6½	Uxbridge, &c., 5 p.c.	80—90	...
1,371,138	July 8	3½	4	Wandsworth Consolidated ...	66—71	...
2,525,768	,,	4	4	Do. 4 p.c. Pref.	63—68	...
1,343,964	Dec. 16	5	5	Do. 5 p.c. Deb.	90—95	...
383,745	,,	4	4	Do. 4 p.c. Deb.	75—80	...
558,342	July 15	6	5	Watford & St. Albans Ord. ...	85—90	...
300,000	Dec. 9	3½	3½	Do. 3½ p.c. Red. Deb. ...	84—89	...

SUPPLEMENTARY LIST

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Jan. 30.	Rise or Fall on week
351,685	Dec. 16	5	5	Brighton, &c., 5 p.c. Perp. Deb.	88—93	...
28,700	,, 17	5½	5½	Do. 5½ p.c. Red. Deb. 1942 ...	95—100	...
415,250	,, 23	4	4	Bristol Gas Co., 4 p.c. New Deb.	83—88	...
140,205	July 29	7	7	Cambridge, &c., 7 p.c. Cons. 'B'	100—110	...
295,932	Aug. 19	5	5	Cheltenham, 5 p.c. Cons. Ord....	88—93	...
42,500	Dec. 16	4	4	Do. 4 p.c. Perp. Deb....	75—80	...
150,000	Aug. 12	4	4	Croydon Gas, 4 p.c. Pref. (Irr.)	65—75	...
130,000	Dec. 30	4	4	Do. 4 p.c. Deb. ...	75—80	...
146,700	Aug. 19	5½	5½	East Surrey, 5½ p.c. Pref. 'A' ...	80—90	...
53,220	,, 19	6	6	Do. 6 p.c. Cum. Pref. ...	90—100	...
117,425	Feb. 5	8	8	East Wight, 5 p.c. Cons. Ord. ...	100—110	...
...	Aug. 19	6	4	Eastbourne, 'B' 3½ p.c.... ...	65—75	...
239,135	Nov. 11	5	5	Gas Consolidation 'A' Ord. (£1)	13/—15/-	...
156,600	Aug. 19	5	5	Hampton C't, 5 p.c. Cons. Ord.	68—73	...
18,000	Dec. 2	7	7	Malta & Med'n., 7 p.c. 1st Pref.	55—65	...
10,845	,, 2	7½	7½	Do. 7½ p.c. 2nd Pref.	55—65	...
50,000	Aug. 19	£5 19 6	£5 4 6	Mid. South. Util., 'A' Cons. 5 p.c.	60—70	...
65,000	Aug. 12	5	5	North Middlesex, 5 p.c. Pref....	87—92	...
70,000	Sept. 9	5	5	Plymouth & Stone., 5 p.c. Deb.	87—92	...
76,501	Dec. 30	4	4	Reading, 4 p.c. Perp. Deb. ...	70—75	...
74,777	Sept. 30	4	4	Romford, 4 p.c. Debs. (Reg.) ...	77—82	...
21,000	Dec. 16	5	5	Slough, 5 p.c. Perp. Deb. ...	87—92	...
211,740	,, 30	5	5	Southampton, 5 p.c. Red. Deb.	90—95	...
363,575	Dec. 30	5	5	Tottenham, 5 p.c. Reg. Red. Mt.	94—99	...
202,019	Oct. 14	6¾	6¾	Tunbridge Wells, 4 p.c. Scale ...	70—80	...
135,257	June 10	5	5	Uxbridge &c., 5 p.c. Perp. Deb.	88—93	...

PROVINCIAL EXCHANGES

Issue. £	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations Jan. 24.	Rise or Fall on week
47,756	July 26	6	5	Bath Cons.	94—98	...
122,577	July 22	7	6	Blyth 5 p.c. Ord.	100—105	...
1,667,250	July 15	5	5	Bristol, 5 p.c. max.	89—91	—1½
120,420	Dec. 16	4	4	Do. 1st 4 p.c. Deb.	92½—94½	...
415,250	,,	4	4	Do. 2nd 4 p.c. Deb. ...	91—94	...
328,790	,,	5	5	Do. 5 p.c. Deb.	107—110	...
157,150	Aug. 5	6½	5	Chester 5 p.c. Ord.	98—101	...
92,500	Dec. 16	4	4	Do. 4 p.c. Pref.	79—84	...
36,430	,,	3½	3½	Do. 3½ p.c. Deb.	79—84	...
41,890	,,	4	4	Do. 4 p.c. Red. Deb. ...	93—97	...
542,270	Aug. 12	9	6	Derby Cons.	100—105	...
55,000	Dec. 16	4	4	Do. 4 p.c. Deb.	77—82	...
10,000	Aug. 19	10	10	Great Grimsby 'A' Ord. ...	165—175	...
6,500	,,	10	10	Do. 'B' Ord. ...	165—175	...
79,000	,,	10	10	Do. 'C' Ord. ...	155—165	...
732,000	Aug. 26	4	4	Hartlepool G. & W. Cn. & New	61—63	...
2,167,410	Aug. 19	6	6	Liverpool 5 p.c. Ord.	97—100	...
245,500	Dec. 16	5	5	Do. 5 p.c. Red. Pref. ...	97½—100½	...
306,083	July 15	4	4	Do. 4 p.c. Deb.	98—100	—1
20,000	Dec. 23	5	5	Long Eaton 5 p.c. Pref.	9—11	...
80,000	,,	5	5	Do. 5 p.c. Deb.	92—97	...
2,430,267	July 29	5 7/10	5	Newcastle and Gateshead Con.	16/6—17/6a	...
682,856	,,	4	4	Do. 4 p.c. Pref.	75—77	...
776,706	Dec. 23	3½	3½	Do. 3½ p.c. Deb.	80—85	...
277,285	Oct. 21	5	5	Do. 5 p.c. Deb. '43 ...	97—102	...
274,000	July 26	5	5	Newport (Mon.) Ord.	89—93	...
13,200	Sept. 16	8⅝	7	Pontyp'l Gas & W. 10 p.c. 'A'	11½—12½	...
13,600	,,	6	5	Do. 7 p.c. 'B'	9½—10½	...
40,000	,,	5	6	Do. 7 p.c. 'C'	9½—10½	...
106,280	Aug. 5	8	10	Preston 'A' 10 p.c.	157—167	...
188,219	,,	7	7	Do. 'B' 7 p.c.	113—123	...
1,806,339	Aug. 26	6½	6½	Sheffield Cons.	114—116	...
95,000	Jan. 6	4	4	Do. 4 p.c. Deb.	96—98	...
332,351	Feb. 5	6	6	Sunderland 6 p.c. max. ...	107—112	...
140,778	Aug. 12	5	5	Weston-super-Mare Cons. ...	80—85	...
64,338	Dec. 30	4	4	Do. 4 p.c. Deb.	75—85	...
33,340	,,	7½	7½	Do. 7½ p.c. Deb.	135—143	...

a.—The quotation is per £1 of Stock. * Ex. div. † Price free of income-tax.

Although these results suggest a satisfactory explanation of the observations of Nichols, i.e., that the temperature of the white oxide was in fact always higher than that of the uranium

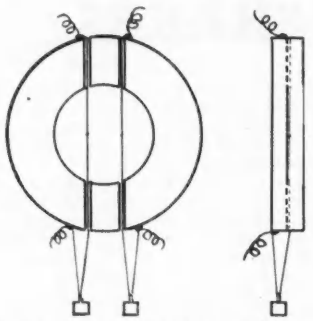

FIGURE 5.—*The Apparatus used to make Direct Measurements of the Temperature of the Emitters, using very fine Thermocouples.*

oxide (black body), it is important to note that there is no simple relationship between the respective temperatures of the two oxides at any particular moment. This, of course, follows from Nichols's observations of the relatively sharp crests in the I_O/I_{BB}—temperature curves. The results thus indicate that within certain ranges the temperature of the white oxide does, in fact, increase abruptly. It seems as though this can reasonably be ascribed only to an abrupt decrease in either the infra-red emissivity or the thermal conductivity of the material. Data on the values of these quantities are inadequate, although Nichols himself has pointed out that the maxima observed in the case of aluminium oxide approximately coincide with breaks in the electrical conductivity-temperature curve of this substance. It is to be expected that the behaviour of the thermal conductivity will correspond approximately with that of the electrical conductivity, but adequate direct measurements are not available. With regard to the alternative explanation, that of a change in infra-red emissivity, it is to be noted from the work of Skaupy and Liebmann, previously referred to, that there are no indications of any abrupt variation of emissivity with temperature. On the other hand, most of their measurements were made with electrically-heated oxides, and it is possible that there may be some effect which is specific to heating by flame.

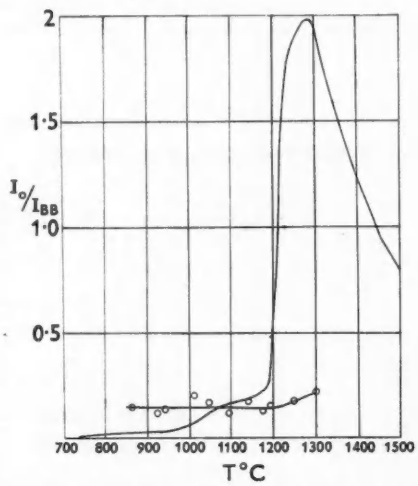

FIGURE 6.—*Values of the Ratio* I_O/I_{BB}, *as given by E. L. Nichols*[14] *for* BeO, *Compared with the Results from the Direct Measurement of Temperature by means of Thermocouples, shown* ooo. (*The measurements could not be extended above* 1,300°C. *owing to chemical action in the fine wires of the couple at these high temperatures.*)

Apart from its special application to this problem, a general survey of the infra-red emissions of refractory bodies heated to various temperatures, either electrically or by flame impact, should be of considerable value in the design of radiators and furnaces. The Gas Research Board has now purchased a suitable infra-red spectrometer, with a specially-designed automatic recording attachment, and this has been allocated for an investigation along these lines.

In order to prove in a manner as accurately quantitative as possible that the emission from materials under consideration is purely thermal in origin, the procedure followed in the previous experiments was modified slightly. The whole of the depression in the alundum block was coated with the substance under test, and a single thermocouple 0·001 in. in diameter supported in contact with it in the manner previously described. The oxide coating was then built up until the couple was coated by as thin a layer as possible, then a thin coating of uranium oxide applied over the whole. The mass was then slowly heated by an oxy-hydrogen flame, and allowed to attain thermal equilibrium at a particular temperature. Simultaneous readings of the optical pyrometer and the thermocouple e.m.f. were then made, then the temperature raised by adjustment of the gas supply and the readings repeated, and so on over the required temperature range. A very thin coating of the material to be tested was then applied, and a similar series of readings made. Finally, a further thin coating of uranium oxide was added, and a third set of readings taken. The two sets of readings with uranium oxide were then used to determine the correction to be applied at a given temperature to the thermocouple readings in order to give the temperature of the surface as determined by the optical pyrometer for each thickness of coating. The mean of these two corrections was then applied to the thermocouple readings for the white oxide, and hence a reasonably accurate value for its surface temperature computed. The corresponding value for the brightness of a black body at this temperature could then be calculated and compared with the actual brightness as indicated by the optical pyrometer. Dividing the latter by the former gave a value for the emissivity of the substance at the particular temperature.

Figure 6 shows a typical set of measurements for beryllium oxide. For the purpose of comparison, the I_O/I_{BB} ratios given by Nichols are plotted on the same scale. It will be noted that the emissivities determined by this method are very much less than unity, and are constant within experimental error. It must be emphasized that owing to the difficulties inherent in a technique employing such very small thermocouples it was not to be expected that the values of the emissivity would be very accurate, but the method was adequate to show conclusively that there is in fact no appreciable emission from these substances which can be regarded as of other than purely thermal origin.

VII LUMINESCENCE AT TEMPERATURES BELOW RED HEAT

The problem of the radiation said to be emitted from certain substances in contact with flame under such conditions that the surface must be at a temperature well below that corresponding to incipient incandescence is in some respects more simple than that already discussed; for any visible or ultra-violet radiation observed must now be luminescent in origin. As stated earlier in this Report, Nichols claimed that this type of luminescence was shown by many pure substances, and that the presence of impurities behaving as "activators" was not essential to the process, although the nature of the radiation emitted might be modified when they were present. On the other hand, the work of the German investigators suggests that the phenomenon is essentially dependent on the presence of a small number of impurity atoms incorporated in the crystal lattice.

A large number of pure substances, including the oxides of calcium, strontium, aluminium, thorium, cerium, barium, zinc and silicon have been tested in the present investigation by coating them on a copper block similar to that used in Nichols's experiments, and allowing a soft hydrogen or oxy-hydrogen flame to impinge on the surface. In no case was any radiation observed with certainty while the surface was below red heat. Subsequently a sample of calcium oxide of doubtful purity was examined. This gave rise to a faint golden-yellow glow in contact with the flame, even when the latter was kept in motion, so that the surface had no opportunity to heat up. The behaviour of the sample was in all respects consistent with the occurrence of a true luminescence, and this result suggested immediately that the failure to confirm the results described by Nichols with the pure oxides must be ascribed to the higher purity of the samples used by the writer. Further, it seemed likely that the view of the German workers that the presence of impurity was necessary was correct.

(*To be concluded in a forthcoming issue*)